ENGINEERING EDUCATION

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Society for the Promotion of Engineering Education

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THE BOARD OF VESTIGATION AND COÖR NATION.

A report will be made the rst day of the convention covering the work so far accom hed by the Board of Investigation and Coördination. ' e Board was organized on September 29, 1922, with the f lowing members:

J. H. Dunlap, to serve one year,
M. E. Cooley, to serve two years,
C. F. Scott, to serve three years,
F. W. McNair, to serve four years,
D. C. Jackson, to serve five years.

The Board has been engaged since its organization in developing and crystallizing plans. It has held five meetings, some lasting two or more days. President Scott, with one or more members of the Board, has presented and discussed these plans with the heads of organizations which are in position to furnish funds. These negotiations give excellent promise of providing, at an early date, the means for carrying on the work in a comprehensive and adequate manner.

It is hoped to secure constructive discussion of the project and the future activities of the Board at the June meeting at which time President Scott will present more detailed information in regard to financing and other features of the work. The Board is more firmly convinced than ever of the usefulness of the results which will be accomplished as the project is carried forward.

It is also anticipated that the report concerning the activities of the Joint Conference Committee of this Society and the National Industrial Conference Board will be a significant feature of the program.

THE ENGLISH DEPARTMENT.

The prospects for an interesting English conference in connection with the annual meeting of the S. P. E. E. seems very encouraging. The English Committee has in reply to its invitation received a large number of letters which not only express interest but give promise of a representative number of English teachers from the engineering schools all over the country. While it has seemed best to continue the policy of our very successful Urbana meeting and not provide for any set papers, the Committee is making a definite effort to secure active participation of a number of men who have definite contributions to make to the discussion of our peculiar problem.

The first session of the Conference will be held at 8:30 A.M., Thursday, June 21. This is a very informal preliminary conference of English teachers and others interested in the problem of teaching English to engineering students. No definite subject has been agreed upon for discussion, since it seems best to allow a perfectly free statement of the problems which demand consideration. Three rather definite groups of problems have, however, been suggested in the letters received from those who expect to be present. It may, therefore, be well to indicate them here.

1. The first question raised has to do with our students. Is there a striking difference in the characteristics of the engineering students in the different sections of the country? For example, is the general attitude of the New England student toward his English work more favorable than that of the student in the middle West? Are these differences sufficiently significant, as affecting our educational problems, to warrant systematic study by either the English Committee or by the new Board of Investigation and Coördination?

2. The second question strikes rather hard at the English

teachers—presumably, of course, those who do not come to our Conference. Have the English teachers themselves discouraged coöperation with the engineering faculties by their indifference and even, at times, by their negative attitude? What sort of men do we need to teach English to engineering students? How shall we induce the right type of teacher to go into this work? How can we get more English teachers enthusiastically interested in our problems?

The Committee will appreciate especially concrete suggestions as to what it can do to help in this matter of teachers.

3. The third question should bring together a large amount of evidence from the experience of those who are present at the Conference. It suggests a thorough consideration of the freshman courses in English. What are the essentials of a first course in English for engineering students? How should the time be apportioned to oral and written work; how can the course best utilize the student's natural interests; how can it widen his horizon and stimulate him to read and think for himself?

It is hardly possible to detail the innumerable questions that suggest themselves. The chairman personally wishes there were time to devote a whole session to this one suggestion alone.

The second session of the Conference will be held Thursday, June 22 at 9:30 A.M. The text for the discussion will be furnished by the clause in the last report of the English Committee, "Our method of procedure must be to establish at all points the closest possible interrelationship between the instruction in English and that in professional subjects." The subject is, therefore, "A Closer Correlation of the Instruction in English with that in the Professional and Technical Subjects."

It is the hope of the Committee that the occasion may prove a real symposium to which many will contribute the experience they have had in establishing in practical form points of contact between the English and the professional

courses. The objective should be to work out some definite plan which can be suggested through the BULLETIN, whereby the training in English may be more continous and more inseparably connected with the student's progress in his professional studies.

The chairman of the English Committee extends this invitation to all who are genuinely interested in the problems of English for Engineering Students. Address communications to,

J. RALEIGH NELSON,
927 Forest Ave.,
Ann Arbor, Mich.

FUNDAMENTALS.

H. E. DYCHE,

Professor and Head, Dept., Electrical Engineering, University of Pittsburgh; Chairman, Committee No. 17, Electrical Engineering.

This Committee in considering the subject "Fundamentals" presented two questions to an equal number of practicing engineers and to engineering teachers:

1. What are the fundamental courses that should be taught in all electrical engineering schools, and

2. Briefly, what should be their scope?

As might be expected the replies are sufficiently general in that they apply equally well to all branches of engineering. Brief extracts from the replies received to date are noted in this preliminary report of the committee in order to facilitate discussion of the subject at the annual meeting in June.

Note: The earlier replies have been arranged in alphabetical order; the later replies in the order of the date of their receipt.

Abstracts of Letters.

"I would suggest, first, that the fundamental courses that should be taught in the electrical engineering schools are those subjects essential to a course in mechanical engineering. . . . " *Geo. I. Alden, Norton Company, Worcester, Mass.*

"A Joint Conference Committee has been appointed, consisting of eight representatives of the National Industrial Conference Board and eight representatives of the Society for the Promotion of Engineering Education. This Conference Committee finds that there is a demand in every direction that the engineering schools limit their courses largely to fundamental subjects but there is a wide diversity of opinion as to what should be the scope of such fundamental courses. In fact, many educators, as well as industrialists, seem to have a very hazy idea as to what is meant by fundamental courses. We believe the outline of such courses will have to be determined by special committees and we have thus far been unable to arrive at any recommendations for the courses which should be taught in electrical engineering." *M. W. Alexander, Managing Director, National Industrial Conference Board.*

"Group I—Fundamental Engineering Subjects; and group II—Essential Related Subjects.

"Group I. I would include the following subjects: Mathematics, through Integral Calculus and including Differential Equations; General Chemistry together with its Inorganic Laboratory; a thorough course in each general division of Physics; Drawing, including Descriptive Geometry; Manual Training, including Carpentry; Pattern Making, Forging, Foundry Work and Machine Shop Practice; Machanical Laboratory including Measurements of Strength of Materials and testing of Mechanical apparatus and Heat Engines; Mechanism; Analytic Mechanics; Mechanics of Materials; Thermodynamics; Theory of Structures; Surveying; Theoretical Hydraulics and Hydraulic Laboratory.

"In group II. I would include the following subjects: European and American History; Historical, Business and Political Economics; English Composition and Literature with as much time devoted to it as possible since engineering students are particularly handicapped by inadequate expression; Public Speaking; two years of Foreign Language; supervised class Physical Training." *Robin Beach, Acting Head, Dept., Electrical Engineering, Brooklyn Polytechnic Institute.*

"I consider the fundamental courses to be Chemistry, Physics, Mathematics, English, Technical Foreign Languages, Drawing and Descriptive Geometry, Mechanism and Applied Mechanics, Shop Practice, Power Engineering, Economics." *Harold W. Bibber, Massachusetts Institute of Technology.*

"The general plan adopted in most of the engineering courses is to plan for the one man out of ten who will require highly technical training. The other nine are forced to study such subjects with the result that they do not have enough time put on the fundamental ground work of the profession. . . .

"This lack of knowledge of fundamentals seem to have permeated our engineering graduates to a considerable extent, and I find that it applies not only to electrical engineering subjects but also into physics, mechanics, and even to English composition. The ordinary engineer of today needs a thorough knowledge of the English language, and of the fundamentals of engineering perhaps more than some of the highly technical subjects which he is getting in the college course. . . .

"... the principles of electric and magnetic circuits, with special reference to electrodynamics and the generation of electromotive force in a magnetic field. I think this should be taught without any separation of alternating current or direct current. . . .

"These courses should consist of textbooks, laboratory work throughout the junior and senior years, of the 4-year engineering course. The first semester of the junior year, and a part of the second semester,

should be devoted to electric circuits. This should be done, having illustrations in the laboratory, of the work taught in the class-room. Toward the end of the junior year the instruction can progress to illustration of the fundamental principles in electrical machines, or transmission lines, and the remainder of the junior year and the first semester of the senior year can be spent on applications of these principles to the more complicated types of alternating current and direct current equipment. The second semester of the senior year will be available for special problems of a more highly technical nature, or for commercial applications that incorporate the fundamental principles." *Morris Buck, Associate Editor, Electrical Railway Journal.*

"For many years I have been of the opinion that a four-year course in engineering, whether electrical, mechanical or any other, should be primarily a four-year course in the fundamentals of engineering and that there has been altogether too much of an attempt to crowd in specialized courses which should more properly be left for a fifth or graduate year work on the part of those who desire to specialize in some one branch of any particular field. . . .

"I think every course should have a strong course in economics, principles of accounting, at least a brief dip into psychology and that the fundamental courses, such as physics, chemistry, mechanics, etc., could well be reinforced to the exclusion of practically all of the specialized courses in any four-year engineering course. I think you will realize that I have come to the viewpoint that we should have a four-year course in *engineering* and a fifth year should be added for electrical engineering, civil engineer, etc., open to those who desired to specialize in any one field. . . . " *M. R. Bump, Chief Engineer, H. L. Doherty & Company.*

"By the fundamentals of a course in electrical engineering I understand that it means those subjects which prepare a man for taking his place as a professional engineer and a course which will make for the greatest success in the long run. I have, therefore, included as being absolutely essential a certain amount of cultural studies. My syllabus of this work follows. . . . " *Paul Cloke, Prof., Electrical Engineering, University of Arizona.*

" . . . I do feel that the policy of Rensselaer in giving every Civil Engineering Graduate the fundamentals of Electrical Engineering, is very good practice. I am under the impression that this method is not followed in most of the Civil Engineering Degrees." *H. M. Dibert, W. & L. E. Gurley Company.*

"In Electrical Engineering there is something like a list of fundamentals such as The Circuital Idea, The Process of E.M.F. Production, The Electron Theory, etc. . . . "

FUNDAMENTALS.

"I know of three ways of using this much used and much abused word 'fundamental.' It is possible to speak of the *fundamental* principles which go to make up a single course. Then there are *fundamental* courses which go to make up the training of an electrical engineer. Lastly there should be going through any course the idea of the *fundamental* method of attack, ... When an engineer describes one unit of our output, *i.e.*, a technical graduate, as entirely lacking in his group of fundamentals, anyone or all three ideas may be implied ... thorough grounding in Mathematics, Mechanics, and Physics. . . . Then there is the problem of deciding just how much Thermodynamics, Engineering Measurements, Chemistry, Hydraulics, and Engineering Materials should be included in an electrical engineering course. Here again it is important not to let the tail wag the dog. The body and soul of the electrical engineering course is Mathematics, Mechanics, Physics and Intensive Electricity.

" . . . Are we not as teachers a little too optimistic when we expect to equip our students with a fundamentalness, finished and perfect to last a lifetime? After over fifteen years of teaching, I find myself every little while adding a little concrete on one place or a little stone in some other place to my own foundation. It seems to me that all we can do in four college years is to haul some of the large foundation stones into place, bind them together, and then rely on postgraduate years for the completion of the foundation and the erection of the subsequent structure." *L. A. Doggett, Professor, Electrical Engineering, U. S. Naval Academy.*

"The fundamental courses should be reading, writing and arithmetic, the more of all three the better, and in electrical engineering, unless one is specializing in wireless, a general knowledge of everything that pertains to electricity, the more the better." *Coleman duPont, Wilmington, Del.*

"Electrical Units, Electrical Circuits, Electro-Magnetics, Electro-Statics, Electrical Measurements, Electrical Machinery.

"Under electrical machinery would come instruction in the basic principles underlying the operation and design of the more commonly used electric machines, such as generators, motors and transformers. This instruction should include both class-room and laboratory work." *D. D. Ewing, Professor, Electric Ry. Engineering, Purdue University.*

"I am of the opinion that these two Colleges represent the best practice of technical education in this country, and I suggest each in their Electrical Engineering Courses represent, so far as manufacturers are concerned, the most desirable type of instruction." *A. P. M. Fleming, Manager, Research and Education Depts., Metropolitan-Vickers Electrical Co. Ltd., Manchester, England.*

"1. Good judgment in all kinds of things. Your engineering schools cannot, perhaps, teach good judgment, but you should certainly encourage the exercise of it.

"2. An intimate knowledge and familiarity of that part of physics which deals with electricity.

"3. All of the rest of the science of physics.

"4. A knowledge of chemistry which includes combustion.

"5. The necessary auxiliary studies to carry out the above, which include Mathematics, English, Mechanics, Economics, etc.

"6. Practice in the use of all of the above, which would include Electric Transmission, Dynamo and Motor Design, Electric Distribution, Central Station Design, etc. . . . " *Robert G. Griswold, Chief Technologist, Henry L. Doherty & Co.*

"Stevens gives only a single course, that of Mechanical Engineering, which is made broad enough so that its graduates enter widely separated branches of engineering. . . .

"My personal feelings are in accord with the general scheme we follow, and are strongly against much specialization. I would almost be inclined to emphasize a branch of engineering in which the student is *not* going to enter, for the reason that his knowledge of such a branch may for many years be simply that which he acquired in college, while his knowledge of the branch which he enters will expand rapidly. I would be inclined to go as far as advising any one particluarly interested in electrical engineering to take mechanical engineering. . . .

"With reference to the 'fundamentals,' I think there may have been some tendency among practicing engineers to advocate the emphasis on fundamentals per se, without sufficiently realizing that fundamentals can only be thoroughly grasped by applying them in a variety of ways. The real excuse for much design work in colleges (where such work is given) is along this line." *L. A. Hazeltine, Professor, Electrical Engineering, Stevens Institute of Technology.*

" . . . there should be a preliminary course not included in many college curriculums on the history of science. All engineers suffer from not understanding the allied sciences when discussed.

" . . . the study of physics, not as purely a textbook matter but as interpretation of natural phenomena and as having constant significance should be recognized in all engineering study." *N. H. Heck, U. S. Coast and Geodetic Survey.*

" . . . would be most effectively improved if much more time and attention were given to the underlying fundamental subjects and correspondingly less to the mere acquisition of information. . . .

"Would not the student of engineering be better able to handle the problems which he will later encounter, if, for example, the physics of

heat, temperature, radiation, conduction, convection, specific heat, etc., were taught in terms of an electric incandescent lamp, rather than in the more or less academic and abstract way?'' *E. P. Hyde, Director of Research, National Lamp Works.*

''1. That the fundamental courses that should be taught in all electrical engineering schools are languages, (including English), history, geography, mathematics, chemistry, physics, economics, and applied science or engineering in some special field.

''2. The scope should be as great as can be adequately covered within the period of college training.'' *A. E. Kennelly, Professor, Electrical Engineering, Massachusetts Institute of Technology.*

''It is my opinion that engineering schools should be well grounded in the fundamentals, the importance of which is indicated by the order of the following list: English, Physics, Mathematics, Mechanics, Chemistry, Economics, and French.

''I am placing English first because I believe that the majority of our engineering schools are exceedingly lame in that subject and yet there is nothing more useful in their work than a thorough understanding of the English language. Very few of the average engineering students can express themselves clearly and when it comes to writing specifications or agreements they are absolutely at sea. It is essential that an engineering student understand the English language above everything else because that is the thing that he will use most. I am choosing the other subjects in the order that I believe will prove most useful to the average student, although of course this may not be borne out by the experience of others. I believe it properly represents my experience in these several subjects.

''I am of the opinion that too much time is spent in some of the engineering schools on design, on shop work and on drawing. I realize that part of this time can be added to a student's work to advantage without overloading his study periods and thereby rounding out in better shape, but some of the schools overdo this and make too much of a drain on the student's energy for work of this kind which is really of secondary importance to his later work as he must of necessity go into a shop to really learn and secure his shop experience as he cannot be taught in a university shop.'' *S. M. Kintner, Manager, Research Dept., Westinghouse E. & M. Co.*

''In electrical engineering I would interpret fundamentals to be the courses in mathematics, physics and perhaps mechanics which are necessary in order to have a proper foundation for the study of the principles underlying electrical engineering.

'' . . . the first introduction to the study of electrical engineering. I realize that there is considerable difference in opinion as to just what

that content should be, and this in turn will depend upon the type of school which is given the course." *P. M. Lincoln, Cornell University.*

" ... the subjects are so extensive that a year's time should be allowed for the preparation of a paper." *C. E. Magnusson, Dean, College of Engineering, University of Washington.*

" . . . It unquestionably means different things depending upon who uses it. . . . A joint conference committee has been appointed consisting of eight representatives appointed by the National Industrial Conference Board and eight representatives of the Society for the Promotion of Engineering Education. . . .

"I am informed that so far the Committee has been unable to come to any conclusion owing to the great differences of opinion as to what constitutes fundamental courses. . . . " *L. A. Osborne, President, Westinghouse Electric International Co.*

"Upon reading your letter of the 16th, my first thought was of the classic remark which Mayor Hylan made to the Queen of Belgium. Seriously, I am giving very careful consideration to the two questions which you raised. . . . " *Harold Pender, Director, Dept. Electrical Engineering University of Pennsylvania.*

"1. What the student must learn in school.

"2. What he must be taught how to learn later.

"I should include a rather thorough training in mathematics, through calculus, and in physics.

" ... economics, including economic history, law, general history, shop-work and shop practice, statistics, and accounting. In these cases the specific instruction should relate to a few fundamentals, but the student should be provided with a picture of what he might learn in the future, and with texts which will enable him to get a running start.

"Finally, I should put a very substantial emphasis on English and report writing," *M. C. Rorty, 195 Broadway, New York City.*

" ... I may say that when we go beyond Physics, Chemistry, Mathematics, Applied Mechanics, Steam and Thermodynamics, Elementary Principles of Electrical Engineering, Mathematical Theory of Electrical Engineering, Electrical Engineering Laboratory, I believe it to be largely a question of personal judgment and surrounding conditions as to what should or should not be included. . . .

"Personally, I should be sorry to see any attempt to define too closely or to attempt to standardize too closely what may or may not be included in the term 'Fundamental Courses' in this connection. Probably some effort in this direction and a certain amount of specification will be advisable if there is no attempt to carry it too far. *H. B. Smith, Professor of Electrical Engineering, Worcester Polytechnic Institute.*

"I cannot overlook the impression which has been made upon me over a period of twenty-five years by the many hundreds of technical school graduates whom I have met. They seemed to me to be over-specialized at the expense of a general education. I would not attempt to lay down the studies of an electrical engineering course, except to say that obviously mathematics is highly important. Beyond that I would strike at fundamentals but that of course, brings us back to your question as to what fundamentals are. Probably, three-fourths of the boys who study engineering will sooner or later work at something else, or at least in occupations where other qualities than engineering knowledge are their success. I think that is a strong reason for steering a middle course in a boy's school equipment. I would give him enough engineering foundation so that he could build upon it to whatever extent his inclination might lead him, but above all I would try to round him out as a man, expanding his interests in other things and especially give him a good dose of English. Most of the technical school graduates are sadly lacking in the use of their mother tongue." *E. H. Sniffin, Manager, Power Dept., Westinghouse E. & M. Co.*

" . . . two questions are really vital, fundamental and far-reaching.

"I have had a little experience in this . . . as a member of the Corporation and on the Visiting Committee of the Electrical Engineering Department, I thought too of making a change in their curriculum, but when we went into it we found it was much more difficult than we had anticipated. There is so much to be given to the students that the difficult question is always one of elimination, and although I haven't tackled the problem recently, at that time the course in Electrical Engineering was the best that I could do." *Gerard Swope, President, General Electric Company.*

"What is *education?* The process of imparting to an individual such (*a*) knowledge of himself, of human society and of nature, (*b*) command of the methods of learning and thinking and of developing in him such (*c*) capacity for decision and execution as will promote his facility and power in dealing with the problems of life.

"What is *engineering?* A body of principles and practices employed in adapting the materials and energy of nature to social and economic ends.

"What things are fundamental to *education as education?*

(1) Knowledge of the human individual (*a*) biological, (*b*) psychological.

(2) Knowledge of human society—(*a*) its history, (*b*) its social organization, (*c*) its economic organization, (*d*) its political organization.

(3) Knowledge of nature (not necessarily based on introductory formal study of natural sciences).

(4) Command of thinking processes—(*a*) rigorous logic of mathematics, (*b*) inductive logic of observational sciences, (*c*) judical logic of social sciences, (*d*) critical and generalizing processes of philosophy.

(5) Powers of expression—(*a*) mother tongue, (*b*) other arts, *e.g.*, music, drawing, painting, sculpture, etc.

(6) Habits of decision and action.

"What things are fundamental to *electrical engineering* as such?

(1) Mathematics—algebra, trigonometry, analytics, calculus, theory of statistics (for all students), differential equations (for occasional students), theory of functions (for occasional students).

(2) Physics—general course and one advanced course.

(3) Chemistry—general course and one advanced course, preferably physical chemistry.

(4) Mechanics—principally statics and dynamics.

(5) Descriptive geometry and some machine drawing.

(6) Heat engineering with laboratory, one year.

(7) Hydraulic engineering with laboratory, one semester.

(8) Electrical engineering, two and one half years—Electromagnetism and electrostatics, electrical machinery and equipment, wave and impulse propagation and transients, laboratory, technical electrical measurements, characteristics of machinery, transmission and transient phenomena, engineering projects." *Wm. E. Wickenden, Assistant Vice President, A. T. & T. Co.*

"... mathematics cannot be too strongly emphasized ... Physics, great stress should be laid upon this course and should be taught independently of the Physics for art and literary scientific students . . . from one to two years of Chemistry and Chemistry Laboratory Work.

"Great stress should be laid upon the study of English during the first two years of his college course, particularly, with reference to speaking and writing correctly, as this is more important than what 'Chaucer' or 'Shakespeare' wrote about some hundreds of years ago.

"I believe that any foreign language such as French, German or Spanish, should be greatly minimized in the engineering course. ... Elementary Electricity should be started in the sophomore year, then he is better prepared fundamentally for the last two years of the heavy engineering work.

"... not enough coördination in the different schools of the country between the different courses taught—that is, the Physics, Mathematics, Electricity and Electrical Laboratory, as well as the mechanical subjects should all be worked out so that there is as direct a connection as

possible between the Mathematical Problems, the Electrical Theory, the Electrical Problems, and the Electrical and Mechanical Laboratories. . . . " *Frank T. Wyman, Packard Electric Co., St. Catherines, Ont.*

"The specifications of industry unfortunately are not precise, and it is therefore impossible to say in advance that the completion of a collective schedule of hours of work in selected studies will fit a student for a particular industry. . . .

"I do not feel prepared to state any definite selection or arrangement of courses at this time, but offer the following partial listed of requisites by industry of the graduates' qualifications as a guide in the selections of those studies: Obedience to discipline; Ability to work in harmony with colleagues; Possession of poise and tact; Ability to observe closely and report correctly; Ability to express himself orally and in writing; Ability to think logically; Knowledge of fundamental subjects (literature, history, sciences—physics, chemistry, geology, astronomy—modern languages, mathematics, economics, psychology); Ability to apply his knowledge; Disposition to increase his knowledge; Decisiveness; Resourcefulness; Ability to convince others; Personal Efficiency. *H. W. Eales, Chief Electrical Engineer, Union Electric Light and Power Co., St. Louis, Mo.*

"Engineering education should consist mainly of the classical subjects which develop power to think rather than the details of practical technique which rapidly become obsolete."

High theoretical proficiency in classical subjects should be expected only from advanced students. *E. F. W. Alexanderson, General Electric Company.*

" . . . generally lacking in two things: first, sufficient knowledge of physics; second, sufficient knowledge of English to make a good statement or write a good report.

"I would regard as a foundation for any engineering course,—Mathematics, Physics and English. For an electrical engineer I would stress the electrical portion of Physics and add to it the special electrical subjects, which you and your colleagues of course have better knowledge of than I have.

"As you know, I have had considerable experience with young men who have been employed under my direction as special apprentices, and a number of them have not been sufficiently grounded in the three points which I mention above.

" . . . desirable to give young men while at college some idea of business law, especially the laws of contracts. . . . " *D. F. Crawford, Vice-President, Locomotive Stoker Co.*

"(*A*) Essential Courses. Considerable time should be devoted to them. Mathematics, Electrical Theory, English, Report Writing, Practical Summer Work, Public Speaking.

"(*B*) Important Courses. A reasonable amount of time should be given to them.

Physics, Chemistry-Metallurgy, Drawing, Mechanics, Electrical Design, Power Plant Operation and Design, Laboratory, Strength of Materials, Railway Electrification, Electrical Transmission, Power Plant and Factory Inspection, Shop Work, Foreign Languages (2), Business Law, Industrial Management, Business Finance.

"(*C*) Valuable Courses. Should be included.

Storage batteries, Thermodynamics, Sources of Information, Electrical Transportation, Hydraulics." *Secor Cunningham, Commonwealth Edison Company.*

"Mathematics up to calculus; Physics, lectures and laboratory work; Chemistry, lectures and laboratory work; one foreign language; a short course in Economics; English; Mechanics; Thermodynamics; Applied Electricity. To these fundamentals other courses looking to specialized trade in any mechanical or electrical work can be added.

"The scope should be broad enough in physics and chemistry to give the student a foundation upon which he can complete any specialized superstructure which his later work may necessitate. Such a foundation should lay emphasis on the breadth of view rather than on too great depth. The courses in English and Economics should be such as will enable the engineering graduate to use English with sufficient correctness to save him from embarrassment, and should deal with the subject from the point of view of practical use rather than through the study of literature. The course in Economics is desirable as giving the engineer a better view of the principles of engineering and appreciation of the enterprises which involve engineering work. *W. B. Gear, Commonwealth Edison Company.*

" ... The thing which perhaps impresses me most along these lines is that pure engineering work in our industry has its very decided limitations, but there seems to be a great opportunity for men in the commericial and accounting branches of our business who have enjoyed the training of mind which is best secured in the obtaining of an engineering education. My observation is that these positions are much more likely to lead to high executive positions than is the case with strictly engineering positions, and in preparing men for this industry I believe it would be will to combine certain courses which would stimulate their interest in the commercial side of the business, and would get them into a state of mind where they could reconcile the expenditure of time

and money in obtaining an engineering education, with the plan of starting in later in some humble position in the commercial side of the business, with the intention of reaching the top." *J. F. Gilchrist, Vice-President, Commonwealth Edison Company.*

"Theoretical and applied electricity; Economics; Mathematics; Physico-Chemistry; General science; Structural design; Modern language.

"The courses in electricity should include the most modern theories and its commercial applications as far as possible without entering specialization.

"Economics should be taught to an extent that will make clear the weakness as well as the strength of the present capitalistic system, of our money system, of our methods of dealing with labor, and the effect of international labor and money conditions upon these important factors in this country.

"Mathematics should be taught to the end that the student mind will be trained to think on scientific matters in terms of mathematics.

"Physico-chemistry should be taught in such a manner that modern theories of material fundamentals are made clear, both with respect to their sufficiencies and deficiencies.

"A course in general science should be available to the student so that his method of thinking would be developed along the line of scientific habit.

"The elements of structural design should be taught to the extent that the student is familiar with mechanical principles underlying incidental structures common to the application of electricity to commercial undertakings.

"Modern languages are useful to the individual student beyond the possible equivalence of professional interpretation, particularly with respect to new theories and developments. It would be desirable to have the course include the practice by speech as well as the interpretation of the written form.

"The foregoing does not include anything of a moral or humanitarian or military nature. It is important, of course, that the student should receive training in the first two respects but I would consider such training a proper part of the general university education rather than as a part of the electrical engineering course." *B. G. Jamieson, Commonwealth Edison Company.*

"I had thought that there was a fairly general consensus of opinion among the engineering profession as to what scientific and technical courses should be given in any electrical engineering curriculum—I mean electricity and magnetism, stationary and moving apparatus, both

a.c. and d.c., drafting and design, the sciences: physics and chemistry, mathematics.

"If Professor Dyche intends to broach the question 'should there be broadly educational courses included in an engineer's education?' that is a very large topic which is receiving the attention of all educational institutions today. I think it is the growing opinion of educators in general that other courses than purely technical and scientific courses should be required of the engineer during his college term, particularly those courses which aid him in his grasp of business conditions. I refer to economics, English, one other modern language, business law, at least one course in political science, philosophy, corporate finance.

"The problem seems to arise from the fact that there is not time during a given four-year curriculum for a student properly to assimilate the underlying technical and scientific principles of an engineering education, to say nothing of the so-called 'broadening' courses, so that it becomes a grave problem to determine whether it is for the student's good to lessen the time at his disposal for purely engineering subjects, or whether, in spite of this fact, the so-called 'broadening' courses do not make him a more practical well-rounded, resourceful engineer in doing the world's work.

"As I said above, I believe the opinion is swinging towards the latter view. There is one other point: The engineers that I come in contact with think that there should be an emphasis placed on the underlying theories of engineering during the college term, as distinguished from specialization, in other words the specialization should be put off as long as possible." *George R. Jones, Public Service Company, Chicago, Ill.*

"Cultural and Commercial Courses: Psychology, English—Grammar and Literature, French, Speech, Business Principles, Economics—Modern Business.

Mathematical Courses: Algebra, Trigonometry, Calculus.

"Electrical Courses: Principles of Magnetism and Electricity, Direct Current Principles, Alternating Current Principles, Electrical Apparatus, Electrical Distribution.

"The scope of all courses should be such as to give the students a very thorough knowledge of fundamental principles. Eliminate the highly theoretical and specialized courses from the undergraduate curriculum." *E. W. Lloyd, Commonwealth Edison Company.*

" ... While you only ask two questions, I am afraid they are pretty large questions.

" ... have had some little experience in employing and handling electrical engineers since 1890.

"In a general way, I have found the tendency of electrical engi-

neers to be extremely narrow and I think any change in the electrical engineering course must be towards the broadening of the foundation of fundamental courses. It must embrace a considerable amount of mechanical engineering and I think should also have some chemistry, metallurgy and economics as well as English. . . .

"I doubt if an electrical engineer can amount to much without also being a good mechanical engineer, and vice versa, and neither will get far without reaching out more or less to several of the other branches.

" . . . the fundamental courses should be Mathematics, Mechanical Drawing, Physics, Chemistry, English, Metallurgy, Mechanics and Economics, in addition to the regular electrical engineering subjects.

" . . . the scope should be limited to the time possible . . . make them rather general and fundamental.

" . . . at the present time, the electrical engineer when he starts in his profession is a good deal like a man 'inside of a barrel.' He is inclined to think the entire horizon is covered by electrical engineering and it seems to take him a good many years to discover that there is a great deal more outside of the 'barrel' than there is inside. . . .

"The first year a young electrical engineer was with us he *knew* that everything we did was all wrong. If he stayed with us a second year he wasn't quite so sure about it, and if he stayed another year or so he found there was some reason for doing it the 'foolish' way he found us doing it." ***C. R. Meston, National Conduit and Cable Co., New York City.***

"The fundamental courses that should be taught in all electrical engineering schools are:

"English and Latin, 2 or 3 years.

"French or German, about two years each, if possible.

"Mathematics, through differential and integral calculus.

"Physics several years, including laboratory work.

"Chemistry, about two years.

"Geology, Astronomy, Botany, about one year each.

"Mechanical Drawing, several years.

"Mechanics,

"Graphical Statics.

"I think that most colleges pay too little attention to the study of English, and that as a result, many graduates are unable to make a clear statement of the problem which they are endeavoring to solve and its solution." ***D. W. Roper, Commonwealth Edison Company.***

"In my view, courses in the following subjects are fundamental: drawing, mathematics, physics, chemistry, electrical engineering theory and laboratory, and mechanical engineering theory and laboratory. A

knowledge of English is fundamental, but I am not sure that courses in it are a fundamental requirement. . . .

"I am not sure that our difficulty is so much in understanding the meaning of the word 'fundamental' as it is in being able to make our students thoroughly learn the fundamentals." *Walter L. Upson, Professor of Electrical Engineering, Washington University.*

" . . . have a broad foundation of cultural education, that is, something of history, language, psychology . . . engineer needs these things in his business just as does the lawyer, the physician and the minister. . . .

"The study of mathematics should be continued until the average mathematical papers on modern mathematical subjects can be read. The point of most fundamental importance, however, in connection with mathematics is that the student gets a clear conception of the meaning of formulæ in physical terms, as formulæ are applied to electrical engineering, and above all, mathematics should be mastered as a working tool rather than as a pleasant sort of mental gymnastics. . . .

"I have used the term 'materials of construction' for want of a better term at the moment. There is a woeful lack of knowledge among the average electrical engineers of the fundamental characteristics of materials which enter into the work, and some study should be given to this subject similar to that which is required for the mechanical engineer and the civil engineer. In some schools this subject is known under the name of 'strength of materials. . . . '

"I would like to add something of the fundamentals of insulation if I knew how to express it, and if I knew where the fundamental information could be had for the teaching of this question. This, I presume, will come as near being found in the study of materials of construction, chemistry, and in molecular physics as anywhere else at the present time.

"I would like to add, finally, that the student should have training in the writing of clear and precise English. There is no more difficult English to write than that of specifications and reports, and few electrical engineers escape the necessity for doing work of this kind. This and a number of other items I have mentioned were sadly lacking in my own education, and I feel, therefore, that having felt the necessity for some of these things, I can speak with authority as to their desirability." *C. E. Skinner, Assistant Director of Engineering, Westinghouse E. & M. Co.*

" . . . first, a thorough course in English, which would enable one to read, write and speak the English language correctly; second, a thorough working knowledge of elementary mathematics, especially arithmetic, algebra and geometry. . . .

"I am not in favor of graduating students from college under twenty-two.

"As to the technical work that should be given in engineering colleges I regard as of maximum importance the fundamental principles of design in direct current motors and generators, series, shunt and compound windings, commutating poles, compensating windings, the fundamentals of alternating current designing, including power factor and the effects of power factor on motors and generators, the fundamental theory of induction motors, transformers, etc. There should be a course in power transmission which would touch on questions of interference as well as proper proportion of copper, reactance and capacity effects, etc. I assume that the fundamental principles of the characteristics of these pieces of apparatus would be taught so that the question of their proper application would follow naturally, so that I do not think it is necessary to have special courses in college for particular applications such as railway work, power stations, or things of that kind. They can be much better learned after graduation." *N. W. Storer, General Engineer, Westinghouse E. & M. Co.*

"In his college course he should be given a very thorough mechanical engineering course. The full course is none too much as a large part of electrical engineering is so closely bound to mechanical engineering that is it impossible to isolate them. He should have a good elementary knowledge of physics, a good knowledge of general chemistry and a reasonable amount of both quantitative and qualitative analyses. He should be trained thoroughly in the English language, not only how to write but also how to speak it on his feet. He should have at least one foreign language, probably preferably French or German, and should be sufficiently well grounded in it to be able to read electro-technical literature and to carry on, perhaps under stress, a reasonably intelligent conversation in the same." *C. S. Cook, Vice-President, Duquesne Light Co., Pittsburgh, Pa.*

"I base my suggestions on experience in handling a great number of students as they come directly from the schools. It is necessary to take these men in hand and give them an additional training in engineering after they come to us, this training, of course, not being intended to correct the defects in the school training, but rather to supplement it.

" . . . a fundamental basis in mathematics, and especially in applied mathematics, there should be a better training in the schools in the *use* of mathematics. . . . When it comes to problems outside their books, they don't seem to be able to know how to 'take hold.' . . . And this training should be more or less drastic in order to 'weed' out those who are totally incompetent in the sense that they have no mathematical aptitudes.

" . . . A student of physics should be given practical problems in

order to obtain a grasp of the principles. It is only when we undertake to *use* the physical laws that we really begin to understand their meanings.

" . . . There are certain fundamental principles in mechanics or dynamics which are of very great use to all engineers and these cannot be properly grasped unless their use is grasped through practical problems or applications.

" . . . design as taught in the schools should be for the purpose of illustrating principles to give the students a better grasp of them. To teach them design in the schools for the purpose of turning out experienced men is simply a waste of time. To teach it from the standpoint of illustration of principles is not a waste of time and in fact, it may be one of the most useful branches in the course, if properly handled. . . .

"In electrical engineering proper, the student should be given a thorough training in elementary principles of direct and alternating currents. If possible, he should be given a physical conception of the phenomena, so that he can visualize or picture them to himself.

" . . . I want to know whether he can use his head when something new comes up. I do not expect him to be an experienced man in any sense, for that must be acquired later, but if he has a good grasp of elementary principles and laws, I feel that at least we have a chance to make something of him.

" . . . The real traits which are more valuable to us are those which, as a rule, are acquired in early childhood and which the colleges can only develop to a certain extent. . . .

"If all the incompetents were 'weeded' out early in the course, then naturally the course could be made correspondingly more difficult and more complete in its later stages and this would be the right and proper thing to do, if possible. I think the laggards in mathematics probably hold back all engineering courses, especially in electrical and mechanical engineering.

" . . . first, to teach the student to use his reasoning powers and to think independently and accurately, and second to use his reasoning powers and independent thinking in the particular courses which he has taken up. The more men of the above kind you can turn out, the higher will be the standing of your school." *B. G. Lamme, Chief Engineer, Westinghouse E. & M. Co., East Pittsburgh, Pa.*

"I believe that the fundamental courses which should be taught in all Engineering schools should be practically the same, no matter what department of engineering is to be studied—that is, a thorough grounding in the principles of mathematics, mechanics and physics together with the basic principles of economics and what is often neglected, a thorough drilling in the English language.

"When I speak of a 'thorough grounding' I mean more the mental discipline that is obtained by rigid requirements in understanding the principles rather than in the accumulation of knowledge based upon certain facts that might be taught. In other words, I believe that the greatest value to the pupil comes from the trained mind rather than a mind stored with knowledge of facts that can be readily obtained when the underlying principles are thoroughly grasped.

"As to the scope of the fundamental course, I believe they should be made emprehensive eneugh to give the student a real grasp of the subjects taught without an effort to make them expert in the practical application of the principles learned. Practical applications can best be learned in contact with industry or the business in which they are to be used." *E. M. Herr, President, Westinghouse E. & M. Company.*

"This profession is divided into so many different specialities, and special instruction in higher mathematics, that metallurgy, chemistry and thermodynamics would be necessary to fit the student for each specialized branch, but these specialized branches are not in my opinion basic as, the one who took up designing of electrical apparatus might have no need for the specialized mechanical and metallurgical knowledge which the one who specialized on electric furnaces would require." *H. D. Williams, President, Carnegie Steel Company.*

" . . . Mathematics. Review of algebra, trigonometry and analytical geometry, 3 to 5 hours per week, 1 year; calculus, 3 to 5 hours per week, 1 year.

"Chemistry. General chemistry 4 hours class, and two 3-hour laboratory periods, 240 hours, 1 year.

"Drawing. Mechanical drawing, 3 hours a week, 100 hours, 1 year; descriptive geometry, 4 hours a week, 240 hours 1 year. In addition, drawing in second year for Metallurgists and Mines, 3 hours a week, 100 hours, 1 year; for mechanicals and electricals, 6 hours a week, 200 hours, 1 year; for civils, 8 hours a week, 250 hours, 1 year.

"English. Composition, oral expression, technical forms, literature, 3 hours a week, 3 years.

"Modern Language. Presupposing two years of language in secondary school, 3 hours a week, 2 years.

"Mechanics. Elementary mechanics and strength of materials, 5 hours a week, 1 year; hydraulics, 3 hours a week, 1 term.

"Physics. General physics 5 classroom and lecture hours, and 2 laboratory periods a week, 1 year.

"Civil Engineering. Elementary surveying except for electricals, 3 hours a week, 1 term.

"Materials of Engineering. Qualities and uses of cement, 3 hours a week, 1 term.

"Mechanical Engineering. Thermodynamics application, 3 hours a week, 1 term; machine design, 3 hours a week, 1 term.

"Electrical Engineering. Elements of electrical engineering, 3 hours class and 1 period laboratory a week, 1 year.

"Mining and Metallurgical Engineering. Elementary metallurgy, 3 hours a week, 1 term.

"Economics, 3 hours a week, 1 year.

"Business Law. A course that shall include specifications and contracts, 4 hours a week, 1 term." *Charles S. Howe, President, Case School of Applied Science.*

" . . . I believe that all electrical engineering courses should include as the fundamental courses mathematics, physics, and chemistry. As time goes on, I am becoming more convinced that we are spending too much time in studying the applications of these three fundamental courses to electrical machinery, or electric transmission, or some other phase of application. I am inclined to believe that General Black was right when he stated in connection with the courses given at West Point, that the engineer can get the specialized applications which he requires when the need for them arises rather than attempting to give any great amount of application work in the engineering course itself."

" . . . coming generation of engineering students should have a very thorough training in the fundamentals of electricity as we now understand them; meaning by this, the electron theory. . . . " *Karl B. McEachron, General Electric Company, Pittsfield, Mass.*

" . . . There should be but one fundamental course in engineering. . . . I would combine electrical, mechanical, civil, chemical and all the other engineering courses in one course of fundamental engineering principles. . . .

"First, Science of Materials and Structures. This to include

materials, elementary principles of physics, chemistry, electricity, steam, mechanics, machine design, and principles of construction generally taken up under the head of mechanics, physics and general design.

"Second, Mathematics. Including simple arithmetic, algebra, geometry, trigonometry, analytics and the first few principles of calculus. In my opinion it is not important to go deeply into higher mathematics, but it is important to acquire facility and skill in the use of fundamental mathematics. . . .

"Third, Economics. This would include costs, growth of population, development of industries, labor history, organization, diagrams, financing and banking, the law of diminishing returns, the law of postponed profits—in short, all of those principles which teach us team efficiency, coincident with and a factor in individual efficiency.

"Fourth, Civics. This would include principles of government as applied to towns, cities, townships, counties, states and the Nation. It should include the study of commercial geography and world markets. It should include history of the government of other civilizations. In short, it should give a perspective of the real values that are developing in what we call civilization.

"Fifth, Expression. This should include English, both written and spoken, including argument, debate, report writing with some attention given to smoothness of form and good style as well as accuracy and clearness in technical detail. This would also include drawing, both mechanical and free-hand. Under this heading come all of those things which develop the facility for communication and ability to present engineering principles in a convincing and interesting manner, as well as to prepare accurate plans and estimates." *C. R. Dooley, Manager, Personnel and Training, Standard Oil Company, New York City.*

" . . . When the average business man speaks of fundamentals in connection with engineering education he usually has in mind a common denominator composed of the infor-

mation and experience essential to success in engineering work; . . .

" . . . include applied algebra, applied trigonometry, practical calculus and engineering problems. The aim should be to teach a working knowledge of the ordinary principles in mathematics and mental habits of analysis. . . .

"Science. Physics and Chemistry. *Scope.* Physics should be covered broadly and thoroughly as it is the foundation for engineering work.

"Technical subjects. Mechanics, thermodynamics, hydraulics, electricity. *Scope.* Each of these subjects should be covered from the standpoint of their application to modern conditions as well as from the purely theoretical standpoint.

"Shops and Laboratories. Mechanical drawing, pattern making, foundry, machine shop, laboratory work coordinated with school room instruction.

"General subjects. Economics, English, industrial organization, commercial subjects. English and Economics should be taught by every instructor as a part of their subject in the curriculum.

"Outside activities. Physical exercise and health, public speaking, current progress in engineering, vocational guidance, practical experience in the business world, contact with people." *H. P. Davis, Vice President, Westinghouse E. & M. Co., East Pittsburgh, Pa.*

" . . . I regret that so many practical (and entertaining) courses are being introduced into our engineering curriculum. I am unalterably opposed to it. I think that it is highly desirable that a student be made to acquire the power of using his mathematics and physics which in reality include all basic engineering. . . . Less shop work and drawing would be one of my specific suggestions.

" . . . Such courses as induction, motors, and railway engineering might well be eliminated and in their stead courses that deal with what actually happens when current flows, $I R$, $I^2 R$, $L I$, $L I^2$, I/X, etc., etc. The student with these things drilled into him will be able as a mature man of suc-

ceeding years to take months or even years and perfect himself in specialities, induction, motors, etc." *Roy Kegerreis, Physicist, Curie Hospital, Mayo Clinic.*

" . . . Should include such subjects as mathematics, physics, chemistry, rhetoric, as well as many other subjects which in my opinion are essential, such as drawing, shop work, language, etc., but whether these courses should be included in the list of fundamentals depends on your definition of fundamental. . . .

" . . . develop correct methods of thinking in the solution of engineering problems. . . . important that the young engineer should thoroughly understand such laws as that of the conservation of energy, and be able to make numerical computations involving the many ways in which these laws appear. If he can do this, he is well prepared for development into a real engineer." *Ellery B. Paine, University of Illinois.*

*LABORATORY INSTRUCTION IN ENGINEERING.

BY ROY KEGERREIS,

Department of Physics,
Mayo Clinic.

The teaching of the laboratory work of engineering courses deserves the serious attention and searching consideration of educators. Yet it has not received as much attention as the relatively unimportant task of teaching left-handed children.

In this paper, the term "laboratory work" is used broadly to include all processes of working out problems by trial, observation, experiment, and similar methods.

In modern education we do not give the student sufficient opportunity to use his reasoning powers, we fail to throw him sufficiently on his own resources; rather we outline definitely what is to be done, and even ask leading, suggestive questions. Such a method may produce much dexterity, but will never produce the ability of correctly forecasting what will happen under given circumstances which is particularly essential to successful engineering.

The rapid growth of engineering during the past few decades has caused educational administrators to add many new courses to the curriculum "in order to keep abreast with the latest developments." We now have so many "developments" that a continuation to this process is obviously becoming impossible, and it may be best to return to the older plan of education; thorough grounding of the student in essential principles with rigid training in the intelligent application of these principles.

So much mathematics and allied subjects are included in the modern curriculum of an engineering school that the philosophy of them is not sufficiently dwelt on; on the con-

* To be presented at the Cornell meeting, Friday June 22, 1923.

trary, analytical acrobatic stunts of a mechanical, rather than a reasoning nature occupy most of the student's time.

I would like nothing better than the opportunity to teach a series of courses in engineering, with most of the computation eliminated, stress being laid on reasoning and the graphic, and I believe that much could be accomplished by such a method.

Laboratory work does not fulfill its true function unless it is closely correlated with the theory studied. Chemistry is an ideal science, in that it abounds in many, and varied problems, which do not require tremendously elaborate equipment, and in its study experiments can be closely correlated with the theory. It might be well for us to pattern the work in other engineering courses to similate these conditions. Do we not spend too great effort in mechanical engineering, for instance, in testing large experimental boilers, locomotives, and so forth? Is that the function of the learning process?

Undergraduate thesis work has often been considered an opportunity for correlating the products of the various processes of learning. My observations of this plan cause me to be unalterably opposed to it; in general, too difficult problems are attempted with not sufficient time. I am, however, enthusiastic about the assignment of less extended original problems. Such a program makes the teaching work more arduous for the instructor, but also more exhilarating.

It is, unfortunately, true that the most desirable men are not always attracted to, or remain in, teaching work. Much has been said in this society about the qualifications of the ideal teacher of engineering, but we are dealing with actualities, not ideals. The problem before us is to secure the best results with the available material, to arouse enthusiasm, initiative, and appreciation of what constitute effective methods of instruction, in the existing faculty members, particularly such as in those who, for various reasons, lack the means, initiative or desire to join this Society and profit by its discussions.

I believe it is thoroughly feasible for an engineering student to secure a perfectly good training, and yet be no more rushed than students in other courses, such as the art courses for instance. It is reasoning power which we should aim to develop, rather then mere manual dexterity and capacity for hard work. It has been my observation that eminently successful men, when producing their best, are not so much prodigious workers as they are thinkers and analyzers with keen insight and ability to preface attacks on problems by sizing up the situation with cool deliberation and unerring judgment.

We have heard of professors (they are happily in the small minority) who pride themselves on the stingy rations of pieces of old wire which they portion out to their students. This is most short sighted. All possible unnecessary labor and time should be saved the student. Arrangements to leave machine sets wired up from one laboratory period to the next, and to leave gauges and thermometers in place and so forth, eliminate much duplication of effort and should be practiced more widely than at present. Longer and fewer laboratory periods allow more to be accomplished than frequent short periods.

As the engineering graduate practices his profession he has to learn the correlation between the different parts of the knowledge which he possesses. Are we not obliged as teachers to present this knowledge so as to continually emphasize the judgment part of the work? The methods of Dickens's Old Scrooge have much to commend them.

Suggestive Problems.

The following five problems are selected at random from different branches of learning in, or allied to, some form of engineering, to illustrate the method proposed. It is a plan for having the student apply what he already knows to new problems, in order to correlate his learning and impress his mind with the unity and continuity of knowledge. So far as the student is concerned nothing is stated except the idea.

1. *Sadiron.* — The ordinary sadiron of the housewife's equipment presents a very practical problem in thermodynamics. It is heated on the kitchen stove and cools off while in use. Could it be improved by being made hollow, and filled with a material which would melt and freeze at the desired temperature, and thus yield its heat of fusion in the cooling? In solving this problem various questions must be answered, some before calculations can be begun, and others only after having done the calculations. Among these are the question of temperature tolerances, the securing of a substance of large heat of fusion with melting point near the temperature for ironing, expansion due to heating, melting and freezing, the pressure developed, and so forth.

Is it feasible to improve the temperature regulations of the electric iron in a similar manner? The broad idea was patented over thirty years ago for application to the electric heater.

2. *Roots of an Equation.* — Mathematics is the most conservative of our basic sciences, the same thing being taught again and again to each succeeding generation. Did anyone ever use Horner's method, as studied in algebra, to find the roots of an equation when coefficients are known to three or four significant figures? If so, it is to be regretted. But if the equation is completely solved by a more approved method, to how many significant figures can one be sure of the roots? This will depend on a number of things which are not treated in any book on mathematics, so far as my search has revealed; yet it is a very practical question and is easily answered by a direct application of the differential calculus.

3. *Lumbering.* — In lumbering, trees are felled mainly by cross-cut saws operated by hand. Could not acetylene welding outfits be used? The advantages are appealing: portable outfits are already available; trees could be cut near the ground, and thus from 1 to 2 per cent. of the lumber conserved; branches could also be trimmed, and the land cleared by grubbing out during the process. The method would

be quick, economical and without excruciating labor. The question of possibility of the trees catching fire and burning would be amongst those requiring consideration.

4. *Magnetic Circuit.* — May a simple transformer magnetic circuit with a primary, secondary and third coil for direct current be used as a stabilizer, or regulator? This is a real problem in electricity, which emphasizes the influence of saturation, leakage, and several other factors. The investigation may be deep or superficial. A graduate student might well be assigned to help a senior on it. Performances could be projected, and then tried ont.

5. *Cleaning of Lighting Fixtures.* — How often should lighting fixtures be cleaned? "The light from lamps deteriorates because of the collection of dirt on the light transmitting or reflecting surfaces, and also because of the inherent falling off in the luminous output of the lamp (due to the blackening of the bulb in the case of incandescent lamps). Neither of these cases can be eliminated, but the effects of the first may be miminized by correct maintenance and cleaning, while the second may be lessened by proper renewal after the efficiency has fallen to such a value that it is most economieal to discard the light-giving unit and replace it with a new one. Two distinct problems are thus involved, in that it is necessary to determine the useful life of a lamp and the proper frequency of cleaning. Considerable study and attention have been devoted to a complete analysis of the former problem, but the latter has been somewhat neglected." —*Electrical World,* Volume 69, 1917, page 1008.

Problems that are fitted for this type of work are legion; all that is needed is interest and initiative on the part of the instructor in collecting or devising them. The mere searching about for such material will freshen the attitude of the instructor, and, will bring him in touch with practical features. It would increase the student's admiration for his instructor by showing that he is in touch with "the world," such an alluring thing to the young mind, and it is easy to

conceive that eventually it might result in the discovery of new advances in science. The average professor does not spend enough time on development work, for which he is eminently fitted.

The success with which boys of the grade schools equip and construct wireless outfits commands attention. The efficacy with which the college-bred man uses his knowledge is vastly inferior to what these youths do with the nebulous smatterings of electrical theory which they possess. Has the intellectual curiosity and desire to find a reason for things, which is epitomized in the perpetual "Why?" of the growing child been dulled in the graduates of our engineering schools? We might well study the mental processes which operate with such different results.

DEVELOPING ENGINEERING EDUCATION.

BY H. C. WOODS,

Robert College, Constantinople, Turkey.

The Society for the Promotion of Engineering Education has not promoted engineering education in as thorough a manner and to the extent which it is generally felt is needed. The presentation of some reasons for this and a possible solution of the problem is the purpose of this paper. The writer feels that having been for some time out of America he may make some criticisms and suggestions which residents would not feel at liberty to make.

In the first place in the good schools there is nothing fundamentally wrong with the type or system of engineering education used. Of course, we can always see places where improvements can be made and, in order to make progress, changes should be made. It is the determination of fixing of the fundamentals and changes involved in keeping up with progress where it would seem that our system is weak.

Charters are granted to schools giving them the right to give engineering degrees but even in the same state the difference in the curriculum of different schools is great and the difference between schools in the various states is still greater. Under the present system of loose charters the only wonder is that the curriculums are so similar and so essentially sound. It speaks well for the high ideals and earnestness of the members of the teaching profession. But, the differences are so great that it is a matter for serious consideration for a student in one school to think of changing to another in the middle of his course. This in itself is not one of our troubles, but the reasons underlying it are, in the writer's opinion, at the root of the trouble.

Among these reasons the following may be clearly recognized:

(*a*) Acceptance of poorly prepared students.
(*b*) Insufficient teaching staff to give a thorough engineering course.
(*c*) Lack of laboratory equipment.
(*d*) Use of poor textbooks.
(*e*) Badly drawn up curriculum because of one or more of the following defects:
  (1) Superficiality.
  (2) Lack of time devoted to fundamentals.
  (3) Little attention given to social and cultural subjects.
  (4) Too much theory given at the expense of practice or vice versa.
  (5) Too much specialization.

The above well-known and generally recognized faults show that something is needed to give engineering education the stamina which we are seeking. We say engineering education when in reality we mean engineering profession. The two are interrelated in this matter. What helps one will help both and each one can help the other. It is the writer's opinion that in this case, the profession should aid education by a service which education should take the initiative in starting.

It has been suggested and individual schools have sought advice from their graduates at various times on how best to improve their product. This shows the right spirit but progress by this method is slow. In our system each school is at liberty to decide what it will require for its degrees. There is no central authority or body to direct matters and legislate as to what training an engineer should be given. The Department of Education in Washington certainly does not and can not. It is well that it has no such powers. Our political system is such that politics would inevitably prevent

it from functioning as it should, had it the power that the Educational Department of the German Government, for instance, has. A school may make any change it pleases within wide limits in its course of study. If it is an improvement it thereby gains but against any new step there is always the retarding influence of the backward schools.

What is needed and wanted is an impartial, interested, intelligent and capable authority to at least draw up a schedule of the fundamentals required for an engineering course. It should wield a greater influence on engineering education than the American Medical Association does on medical education and much greater than the Bar Association does on legal training. Federated American Engineering Societies has the standard and personnel such that it could well undertake such a task.

There should be drawn up a schedule of minimum requirements for grading technical schools. These requirements should at least state: (*a*) the number of credits required for graduation, (*b*) the fundamental subjects and minimum time to be given to each, (*c*) in case of laboratory courses the minimum requirements as to apparatus and experiments, (*d*) textbooks suitable for certain purposes, (*e*) the amount of work to be carried by any one teacher.

A system of grading based on classification requirements drawn up in advance would (*a*) aid the engineering educators who are trying to improve their schools; by (*b*) furnishing a spur to backward schools, (*c*) give standing to those doing good work but not being well known, (*d*) eliminate some schools from the engineering field, (*e*) give a clear field for schools desiring to train foremen and skilled workers. (In America we have very few such schools which in France is exemplifed in the "Ecole des Arts et Metiers" which in no sense is a rival to the "Ecole des Ponts et Chaussees").

The Federated American Engineering Societies, being a non-political organization, could draw up requirements on the basis of what is good for the profession, and grade schools

on the basis of the results of inspections which should be made regularly. Thus, in the course of time the quality of men found in the engineering profession would be greatly improved, the question of standing would settle itself because when a larger proportion of capable men with the qualities of leaders grow up in the profession they will attain the place in the esteem of the nation that the profession makes possible.

THE NATIONAL BOARD ON PERSONNEL CLASSIFICATION.*

On January 6 a conference was held at the National Research Council to discuss ways and means of securing more uniform forms and more standard terminology in personnel classification. Delegates from seventeen organizations interested in this work attended. The conference agreed that the organizations actively working on personnel classification fell naturally into seven major groups as follows:

The National Management Association.
The Joint Committee on Terminology of the Engineering Council.
The Federal Government.
The National Assembly of Civil Service Commissions.
The American Federation of Labor.
The National Research Council.
The American Council on Education.

All of these groups were already organized excepting the Federal Government. It was, therefore, recommended that steps be taken to create a Committee on Occupational Terminology and Specifications composed of delegates from those offices in the Federal Government that make constant use of personnel specifications. This committee has been created and is composed of one delegate each from the Civil Service Commission, the Census Bureau, the Bureau of Labor Statistics, the Veterans Bureau, the Federal Board for Vocational Education, the Bureau of Efficiency, and the Department of War and Navy.

The conference also instructed the chairman to invite the seven major groups to appoint one delegate each to a National Board on Personnel Classification. The first meeting of this Board was held on March 31 in the offices of the

* *The Educational Record*, Vol. IV, No. 21

American Council on Education, with the following delegates present:

J. A. Randall, representing the National Management Association.

L. W. Wallace, representing the Joint Committee on Terminology, of the Engineering Council.

R. W. Briggs, representing the Federal Government.

C. O. Messick, representing the National Assembly of Civil Service Commissions.

Oliver Hoyem, representing the American Federation of Labor.

L. L. Thurstone, representing the National Research Council.

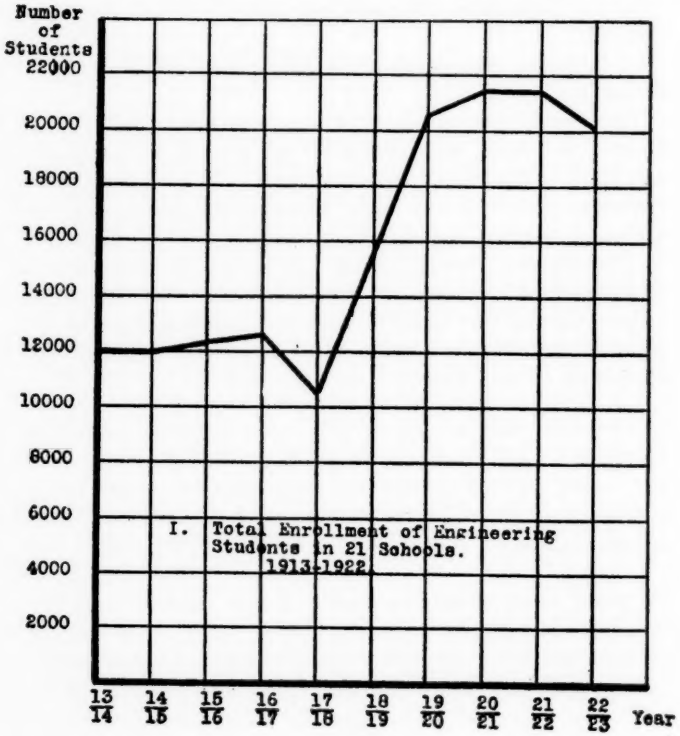
C. R. Mann, representing the American Council on Education.

The Board elected C. R. Mann, chairman, and Oliver Hoyem, secretary, and appointed an Executive Committee composed of the four members resident in Washington. The functions of the Board were discussed at length and the ways and means of securing coöperation of the several groups in promulgating standard forms for personnel classifications and standard terminology were outlined. The Executive Committee was instructed to draw up a full statement of the problem and the proposed plan of attack for detailed consideration of the Board.

FLUCTUATIONS IN STUDENT ENROLLMENT IN ENGINEERING COURSES IN AMERICAN UNIVERSITIES AND COLLEGES.

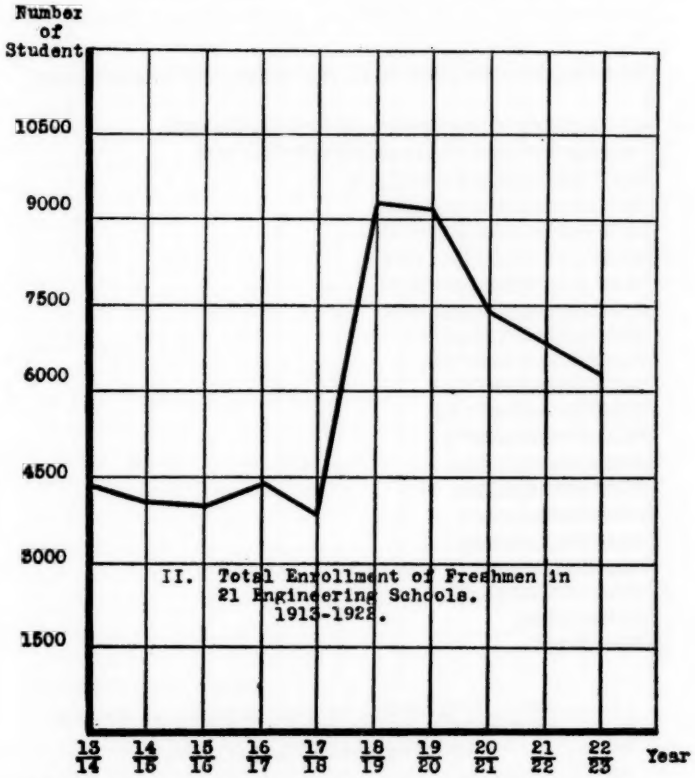
BY ALAN BRIGHT, Registrar, and W. F. RITTMAN, Professor of Commercial Engineering, Carnegie Institute of Technology

Many engineers and educators are of the opinion that the interest in engineering as a profession varies with the commercial prosperity as well as with the normal growth of the



I. Total Enrollment of Engineering Students in 21 Schools. 1913-1922.

country. Educators have reached the conclusion that the mortality of engineering students is high. The first of the above conditions would appear to be a natural sequence of human events; the second would indicate an error in choice

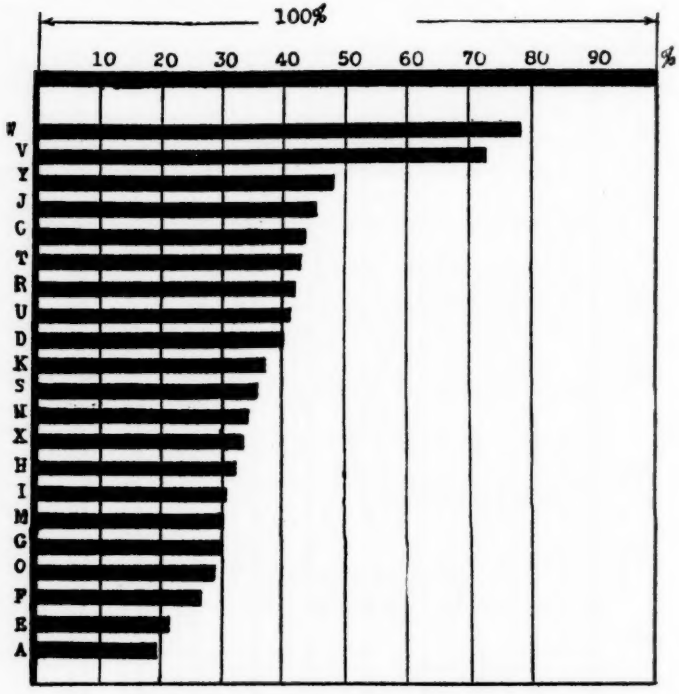


II. Total Enrollment of Freshmen in 21 Engineering Schools. 1913-1923.

by the student, a lack of sufficient and sound preparation, or a faulty program.

In order to determine conditions and trends in interest in Engineering and in the mortality in engineering courses, the authors have secured comprehensive enrollment figures of

engineering students in twenty-one colleges, universities, and institutes. In order to make the conclusions reached more tenable, a sufficient number of institutions were selected with due respect to geographical location. As the data were fur-



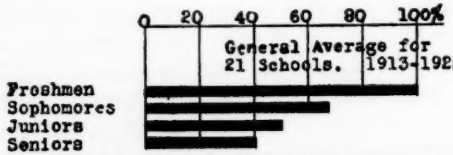
III. Ratio (expressed in percentage) of Seniors to Freshmen in 21 Engineering Schools. During Period 1913-1922.

nished by responsible officers of the institutions involved, they were accepted as authentic. The data are presented in the form of curves or graphs, and not in the form of tables, inasmuch as the purpose of the study was to determine trends in the engineering field of education.

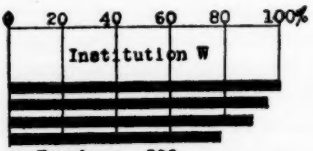
Curve I shows the numbers and changes in total enrollment of engineering students in the twenty-one institutions under consideration. It is frankly recognized that these total numbers fall far short of the total enrollment of students in engineering in America. It is believed, however, that the trend is definitely in harmony with that of the entire country. The curve clearly shows that during the world war and immediately following, the number of engineering students increased at a rate unprecedented theretofore and reached a maximum in 1920. The 1920 enrollment is nearly 80 per cent. greater than the somewhat constant registration existing in 1913 and 1914.

Curve II shows the numbers and changes in freshman enrollment of engineering students of the institutions. It is believed that this curve shows the attitude and changes in attitude of the general public toward engineering as a profession. The World War appears to have given a tremendous impetus to public interest in the study of engineering. This impetus is very probably the result of the fact that modern warfare is almost entirely a matter of applied engineering in all its branches. Never in the history of the world were engineers of greater importance and in greater demand than during the period from 1915 to 1920. The dropping off in the enrollment of freshman engineering students from 1919 to 1922 was but a national reaction from the abnormal increases of 1918 and 1919, aided by the industrial depression of 1920 to 1922. Added to these conditions there was a decreased demand for engineers. It is believed that with the present revival in commercial and industrial activity the demand for engineers is growing and that this increased demand will be expressed in terms of a sustained, if not increased, enrollment during the coming years. As in the case of Curve I, it is recognized that these figures are not absolute totals for the country, but it seems evident that they do definitely represent trends.

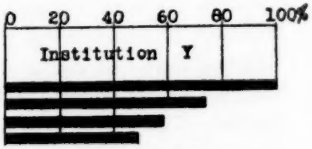
Curve III, expressed in terms of percentage, shows the



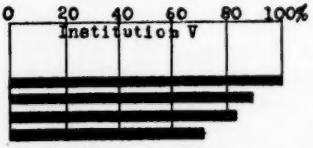
Average number Freshmen, 1913-1922, 289.
Average number Sophomores, 1913-1922, - 194. Loss 32.8%.
Average number Juniors, 1913-1922, - 145. Loss 16.9%.
Average number Seniors, 1913-1922, - 117. Loss 9.8%.



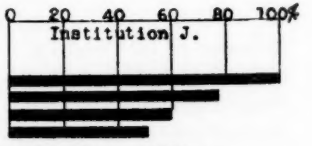
Av.Freshmen -525-
Av.Sophomores504- Loss 4%.
Av.Juniors -471- Loss 6.6%.
Av.Seniors -412- Loss 12.8%.



Av. Freshmen -222-
Av.Sophomores -163- Loss 26.6%
Av.Juniors -128- Loss 15.4%
Av.Seniors -108- Loss 9.4%.

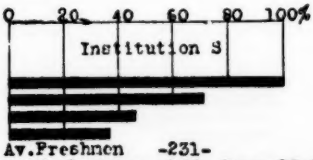


Av.Freshmen -157-
Av.Sophomores-141- Loss 10.5%
Av.Juniors -131- Loss 6.5%
Av.Seniors -114- Loss 10.2%

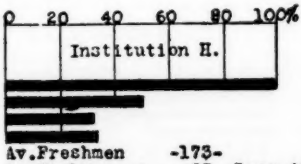


Av.Freshmen -298-
Av.Sophomores-228- Loss 23.5%
Av.Juniors -178- Loss 16.8%
Av.Seniors -136- Loss 14.2%

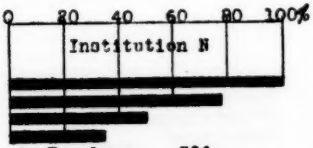
IV. Detailed Ratios of Enrollment in 21 Engineering Schools. 1913-1922.



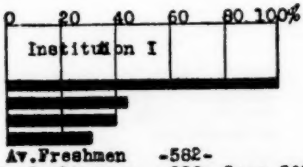
Av.Freshmen -231-
Av.Sophomores -163- Loss 29.5%
Av.Juniors -107- Loss 24.3%
Av.Seniors - 85- Loss 9/6%



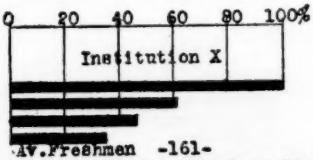
Av.Freshmen -173-
Av.Sophomores - 87- Loss 49.6%
Av.Juniors - 56- Loss 18.0%
Av.Seniors - 58- Gain 1.1%



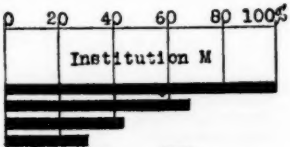
Av.Freshmen -396-
Av.Sophomores -307- Loss 22.4%
Av.Juniors -199- Loss 27.3%
Av.Seniors -138- Loss 15.3%



Av.Freshmen -582-
Av.Sophomores -258- Loss 56%.
Av.Juniors -233- Loss 4%
Av.Seniors -180- Loss 9%

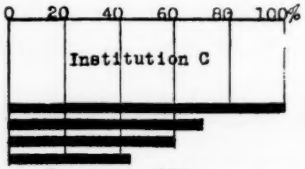


Av.Freshmen -161-
Av.Sophomores - 99- Loss 38.5%
Av.Juniors - 75- Loss 15.0%
Av.Seniors - 66- Loss 12.0%

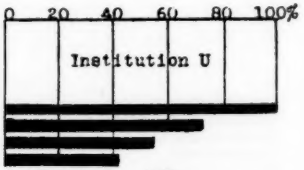


Av.Freshmen -370-
Av.Sophomores -251- Loss 32.2%
Av.Juniors -163- Loss 23.8%
Av.Seniors -112- Loss 13.8%

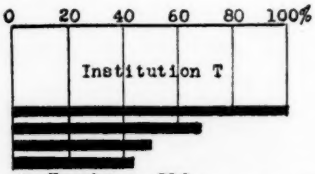
IV (b) Detailed Ratios of Enrollment in 21 Engineering Schools. 1913-1922.



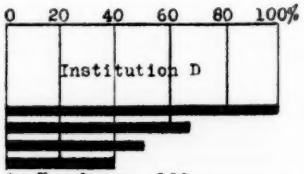
Av.Freshmen -351-
Av.Sophomores245- Loss 30.2%
Av.Juniors -211- Loss 9.7%
Av.Seniors -156- Loss 15.7%



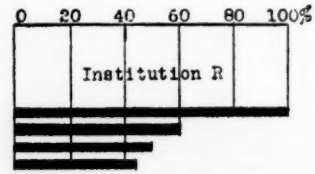
Av.Freshmen -187-
Av.Sophomores134- Loss 27.9%
Av.Juniors -105- Loss 15.8%
Av.Seniors - 80- Loss 13.5%



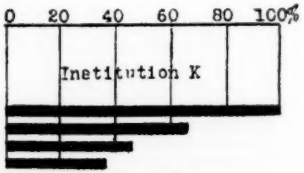
Av.Freshmen -310-
Av.Sophomores207- Loss 33⅓%
Av.Juniors -157- Loss 16.0%
Av.Seniors -136- Loss 6.7%



Av.Freshmen -120-
Av.Sophomores- 81- Loss 32.6%
Av.Juniors - 60- Loss 17.4%
Av.Seniors - 48- Loss 9.6%

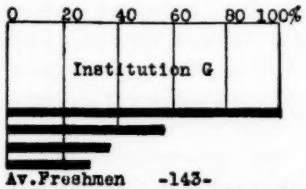


Av.Freshmen -224-
Av.Sophomores -136- Loss 39.2%
Av.Juniors -111- Loss 11.6%
Av.Seniors - 99- Loss 5.8%

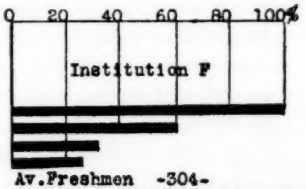


Av.Freshmen -551-
Av.Sophomores-365- Loss 34%.
Av.Juniors -253- Loss 20.2%
Av.Seniors -205- Loss 8.6%

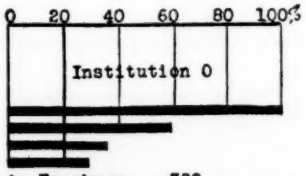
IV (a). Detailed Ratios of Enrolment in 21 Engineering Schools. 1913-1922.



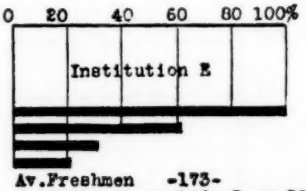
Av.Freshmen -143-
Av.Sophomores - 80- Loss 44.3%
Av.Juniors - 53- Loss 18.9%
Av.Seniors - 43- Loss 6.7%



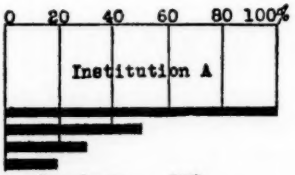
Av.Freshmen -304-
Av:Sophomores-187- Loss 38.5%
Av.Juniors -103- Loss 27.9%
Av.Seniors - 81- Loss 7.1%.



Av.Freshmen -320-
Av.Sophomores -189- Loss 41.6%
Av.Juniors -115- Loss 22.7%
Av.Seniors - 93- Loss 6.9%



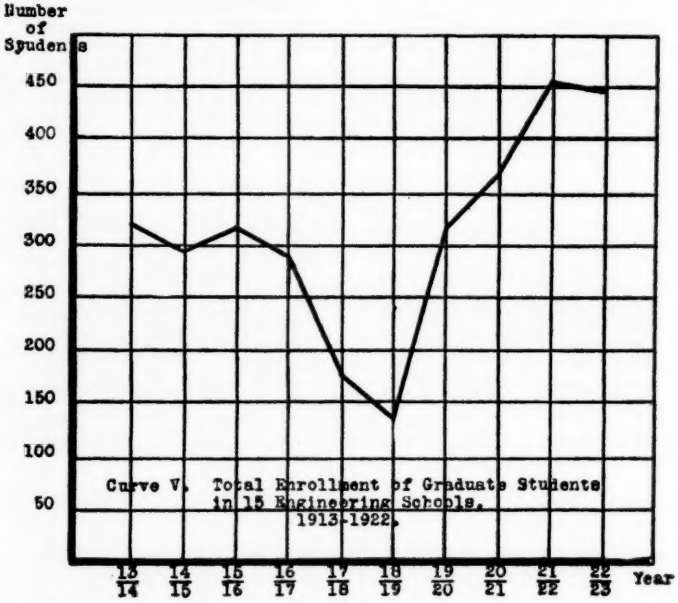
Av.Freshmen -173-
Av.Sophomores -108- Loss 38.0%
Av.Juniors - 57- Loss 29.3%
Av.Seniors - 37- Loss 11.4%



Av.Freshmen -270-
Av.Sophomores -139- Loss 48.5%
Av.Juniors - 82- Loss 21.1%
Av.Seniors - 53- Loss 10.9%.

IV. (c) Detailed Ratios of Enrollment in 21 Engineering Schools. 1913-1922.

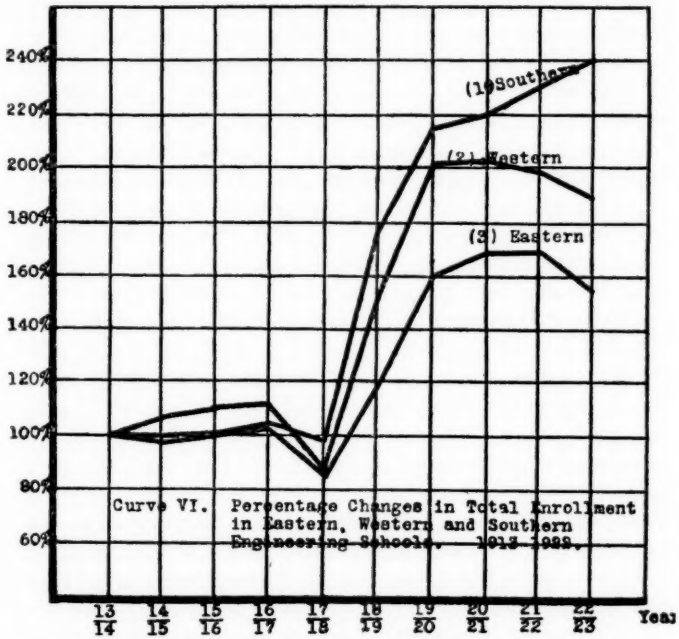
ratio of engineering freshmen to seniors. These percentages vary from as high as approximately 80 per cent. to as low as approximately 20 per cent. of those who enter as freshmen and who remain until their senior year.



Curve V. Total Enrollment of Graduate Students in 15 Engineering Schools, 1913-1922.

Certain institutions receive a large percentage of their upper class students from the academic colleges who register with advance standing. As a matter of economy many students, especially in the middle west, prefer to attend an institution near home for one or two years and then enter a more distant engineering school, even at the expense of spending five years in college. It is not infrequent that heads of engineering schools urge those who can afford it to graduate from an academic college before entering an engineering school. This tendency accounts for the lower mortality in the upper years of the engineering courses at certain

institutions. These data, however, should be considered in conjunction with those of curve IV for individual institutions. Graph IV, expressed in terms of percentage, shows the proportion of freshmen, sophomores, juniors, and seniors, in all the institutions under observation. By far the greatest decrease in numbers here is in the freshman year. The data



Curve VI. Percentage Changes in Total Enrollment in Eastern, Western and Southern Engineering Schools, 1913-1923.

and proportions of numbers in the different classes and the different institutions are of such general interest that graphs are presented for all of the institutions under consideration. No attempt is made here to account for the high freshman mortality or to suggest any remedies. This subject has brought forth varied opinions. Some contend that the college freshmen are young people who require guidance and direction which the universities are failing to give. Others believe

that the freshman year is the logical time in which to eliminate those unfitted for engineering work. The purpose of this article is to show in definite and in graphic form the extent of enrollment variations in engineering courses in typical institutions.

Curve V shows the total number of graduate students in fifteen of the institutions during the period from 1913 to 1922, inclusive. Here it will be noted that instead of an increase during the war, there was a marked falling off, explained, perhaps, by the fact that most graduate students entered technical branches of the government service. The return of these graduates to their courses combined with the entrance upon graduate work of many others, resulted in a remarkable increase, the maximum being reached in 1921, with practically no falling off in 1922. These data clearly show an appreciation of advanced preparation and study beyond that afforded by the usual undergraduate course.

Curve VI expressed in percentage, with 1913 enrollment considered as 100 per cent., shows the changes in enrollment in engineering in various parts of the United States. The geographical division, represented in the curve, was made broadly by considering as eastern those institutions in the northern half of the territory east of the Mississippi River; as western, those in the northern half of the territory west of of the Mississippi; and as southern,those institutions in the southern states. There is a marked difference in these three groups. It is to be noted that the Eastern institutions have had a greater falling off in enrollment during the past few years and that the Southern institutions have had the least. From the curve it will be seen that the institutions which draw students from the large industrial centers have been visibly affected by the after war depresssions while the more agricultural regions, remote from industrial districts have not been subject to this disturbance.

LETTER TO THE EDITOR.

Having been interested for a good many years in developing psychological *tests* and constructing *testing machinery* for the testing of *special native endowments* (in contradiction to both general intelligence tests and tests in school subjects), I have studied with intense interest the report of your committee 22 as presented by Mr. L. L. Thurstone in the January number of ENGINEERING EDUCATION. Maybe you would publish the following summary of the report as it appears to me, leaving out of consideration all minor points of difference of opinion. The five results of the whole investigation are these:

1. If you wish to predict success in a curriculum loaded with mathematics, physics, chemistry, mechanics and drafting, rely on a test made up of problems in arithmatic, algebra, physics and geometry rather than on a test ("examination," if you prefer,— it's the same thing) in English composition and English literature.

2. For success in a curriculum loaded with mathematics, physics, chemistry, mechanics and drafting a so-called "psychological intelligence test" has no more predictive value than a test in English composition and literature. (Compare what is said above under 1.)

3. For success in a curriculum loaded with mathematics, physics, chemistry, mechanics and drafting a test in "technical information" of the popular kind, when given to high school graduates, has no predictive value whatsoever. (I have heard the dean of our College of Agriculture make similar statements about agriculture, merely on the basis of his experience with city boys, who often turn out splendid agriculturalists.)

4. No matter what the subject matter of any test or examination, it has a much greater predictive value if the same well devised test is given in the same manner to 300 students and the same system of grading is applied, than if 200 different school teachers give tests of their own invention (though in a similar subject matter) and use each his own method of grading, and a central office then tries to elaborate

out of these 200 heterongeneous reports a prediction of success for those 300 hundred students.

5. "The native endowment" of a stranger is measured by a so-called intelligence test only "as nearly" (better, "as remotely") as it is measured by any "general high school graduation test" or any "college entrance test" as commonly given, except for what has been said above under (4).

To this I should like to add the following personal conviction. "General intelligence" is by no means a psychologically justified, scientific term referring to a definite, definable and defined character which is inheritable. The outcome (y) of a general intelligence test, briefly called "intelligence test," depends about to one-third on scholastic opportunities (p), to one-third on the social and geographical surroundings (q), and to one-third on native endowment of a multiple kind ($x = n'a + n''b + n'''c$, etc.).

$$y = p + q + x.$$

It becomes a "quasi" measure of "the native endowment" only and increasingly as the parameters p and q can be made to approach constant values among the individuals tested,—a task which we psychologists have not yet accomplished, and shall never accomplish unless we throw first the term "general intelligence" overboard and approach the problem in a new manner. And even then we shall measure a sum of heterogeneous quantities of the kind a, b, c, etc. Intelligence is no more capable of being measured in units of intelligence than a person's health is capable of being measured in units of health.

Success in the engineering profession can be foretold only by special tests which will have to be demonstrated as suitable to the engineering profession. In this respect the committee's report has not brought us any enlightenment over that which we had previously.

Max F. Meyer, Executive Secretary,
Kansas-Missouri Branch,
The Psychological Corporation.

MEMBERS ELECTED SINCE PUBLICATION OF YEAR BOOK.

AGG, T. R., Professor of Highway Engineering, Iowa State College, Ames, Ia.

BRACKETT, R. D., Instructor in English, University of Michigan, Ann Arbor, Mich.

CARLOVITZ, G. H., Instructor in Electrical Engineering, Vanderbilt University, Nashville, Tenn.

CAYWOOD, T. G., Associate Professor of Descriptive Geometry and Drawing, University of Iowa, Iowa City, Iowa.

CRAIG, DUDLEY P., Instructor in Mechanical Engineering, Purdue University, LaFayette, Ind.

CURTIS, D. D., Instructor in Mechanics and Hydraulics, University of Iowa, Iowa City, Iowa.

DAWSON, F. M., Associate Professor of Mechanics, University of Kansas, Lawrence, Kans.

EKSTRAND, K. H., Instructor in Mechanical Engineering, University of Iowa, Iowa City, Iowa.

GEIGER, J. W., Instructor in Mechanical Engineering, Purdue University, LaFayette, Ind.

HALE, Charles, Associate Professor of English, Rutgers College, New Brunswick, N. J.

HENDRIXSON, N. E., Chief Engineer, Moter Spring Company, Toledo, O.

HOLT, A. H., Associate Professor of Civil Engineering, University of Iowa, Iowa City, Iowa.

HOPKINS, L. A., Secretary, Colleges of Architecture and Engineering, University of Michigan; Assistant Professor of Mathematics.

HUNT, G. H., Instructor in Applied Mathematics, University of Southern California, Los Angeles, Calif.

INGALLS, J. W., Assistant Professor of Civil Engineering, Northeastern University, Boston, Mass.

JONES, J. C., Professor of Geology, University of Nevada, Reno, Nev.

LAFRENIERE, T. J., Sanitary Engineer, 59 Notre Dame East, Montreal, Canada.

MACKINNON, LEE W., Director of Junior College, University of the City of Toledo, Toledo, O.

MARUTH, C. H., Assistant Registrar, University of Iowa, Iowa City, Iowa.

MILLER, W. J., Professor of Electrical Engineering, Oklahoma A. & M. College, Stillwater, Okla.

NETSCHERT, WM. JR., Professor of Mechanical Engineering, Newark Technical School, Newark, N. J.

NISSAR, A. R., Deputy Head, Electrical Engineering Department, Victoria Jubilee Technical Institute, Byculla, India.

NUTTING, P. J., Manager, Toledo Factory, Combustion Utilities Corporation, Toledo, O.

PEET, J. C., Professor of Electrical Engineering, Newark Technical School, Newark, N. J.

PRAGEMAN, I. H., Instructor in Descriptive Geometry and Drawing, University of Iowa, Iowa City, Iowa.

O'BRIEN, A. V., Superintendent of Engineering Shops, University of Iowa, Iowa City, Iowa.

SCOTT, R. C., Assistant Professor of Civil Engineering, The Ohio State Uuiversity, Columbus, O.

SHERWOOD, G. F., Associate Professor of Mathematics, University of Southern California, Los Angeles, Calif.

SHOWMAN, H. M., Assistant Professor of Mathematics, University of Southern California, Los Angeles, Calif.

SLOANE, R. C., Assistant Professor of Civil Engineering, The Ohio State University, Columbus, O.

STEWART, V. T., Professor of Chemical Engineering, Newark Technical School, Newark, N. J.

STOVALL, SAMUEL C., Instructor in Machine Design, Georgia School of Technology, Atlanta, Ga.

WATERMAN, E. L., Associate Professor of Sanitary Engineering, University of Iowa, Iowa City, Iowa.

WATTS, A. S., Professor of Ceramic Engineering, The Ohio State University, Columbus, O.

WOOD, K. D., Instructor in Mechanics of Engineering, Cornell University, Ithaca, N. Y.

WORK, L. T., Instructor in Chemical Engineering, Columbia University, New York City.

COLLEGE NOTES.

The Case School branch of the Society for the Promotion of Engineering Education held its third neeting of the year on April 20, following a dinner at the Case Club.

Instead of having a program of prepared papers or speeches, we sat around in a great circle and had what had been announced beforehand as "An Informal Discussion of Class Room Experiences." The discussion was led by some of the senior members of the faculty and was full of interest and helpful suggestion both, especially from the standpoint of the newer and younger instructors.

The following officers were elected for the coming year:

K. O. Thompson, *President.*

A. Jenkins, *Secretary and Treasurer.*

Program Committee:

R. H. Danforth,

W. D. Trautman,

A. A. Hausmann.

North Carolina State College of Agriculture and Engineering.— On Friday, May 4, the student branch of the American Society of Mechanical Engineering of State College gave its second annual Exhibition Day which marked the formal opening of Page Hall into which the Mechanical Engineering Department has recently moved.

This building was named in honor of Walter Hines Page, who was actively interested in the establishment of an Engineering School in North Carolina. The building is 170 feet long by 71 ft. 6 ins., wide. It is built of brick trimmed with terra cotta and granite and is fireproof constructed throughout. All the floors are supported on steel frames and metal lumber, and all door frames are hollow metal, the windows being wired glass. The first floor contains the executive offices of the Department of Mechanical Engineering, a li-

brary, three class rooms, and two drafting rooms. The second floor contains four drafting rooms, one class room, three offices, and a well-equipped blue-print room. The basement consists of one large room, at present used for the Auto Repair department, but which will in all probability be the temporary home of the Engineering Experiment Station, which was provided for by an appropriation by the recent State Legislature. The drawing-rooms are well-lighted and ventilated, constructed according to the most modern design. The blue-print room has recently been equipped with the latest model of Pease Vertical blue-print machine.

When the new equipment, much of which will be built in the College shops has been installed, Page Hall will be one of the most complete buildings for the teaching of Mechanical Engineering in the South.

Just to the rear of Page Hall is the Shops Building, which contains the machine shop, forge-shop, foundry wood shop and mechanical engineering laboratory.

The department is in charge of Professor L. L. Vaughan. Associated with him are: W. J. Dana, J. M. Foster, C. B. Park, E. L. Cloyd, T. J. Martin, W. S. Bridges, H. B. Briggs, G. W. Price, Fred B. Wheeler, and H. J. Jones.

BOOK REVIEWS.

Electricity and Its Application to Automotive Vehicles.
By PAUL MCDOWELL STONE (Michigan State Automobile School). Cloth bound, 6" x 9" — 844 pages — 371 illustrations. $4.00.

"A piece of work well done." This book is one of the best, if not the best of its kind, supplying a need of the automotive service. Any automobile mechanic, owner or student can use this book very profitably, as the principles of electricity and magnetism are so clearly and simply explained, that any one with little or no knowledge of the principles of electricity can get these principles by studying this book. The first part of the book is devoted to the explanation of all the fundamental principles upon which the electrical systems of the automobile depend for their operation. All necessary information applying to the care, operation and testing of primary and storage cells, when in use or out of the car, is very well handled. Electrical measuring instruments, testings instruments, battery ignition systems and all makes and types of magnetos, spark plugs, relays, regulators, electric motors, electric generators, etc., are explained in detail.

The chapters on trouble shooting, and car illumination are very complete. In fact this book could well be named, "The Encyclopedia of Automotive Electrical Systems." It meets the needs of all automotive schools and service stations, both electrical and general, and in fact could be adopted by the institutions of higher learning to cover the electrical end of their automotive engineering courses.

PERSONALS.

Henry J. Spooner has retired from the directorship of the Polytechnic School of Engineering, London, after forty years of service. His address is now 5 St. George's Terrace Regent's Park, London, N. W.

The Presidents and Members of the Boards of Directors of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers held a luncheon in honor of Dr. Emmanuel de Margerie, visiting professor to a group of American Universities in an exchange of professors in science and engineering with the Ministry of Education of the French Republic at the Harvard Club, New York City, May 18.

The guests on this occassion were his Excellency M. Jules Jusserand, Ambassador of the French Republic; Dr. Emmanuel de Margerie; Dr. Stephen P. Duggan, Director of the Institute of International Education; and Dr. Charles F. Scott, President of this Society.

BOOKS RECEIVED.

Structural Members and Connections. By GEORGE A. HOOL and W. S. KINNE, Editors-in-Chief. McGraw-Hill Book Co., Inc.

Applied Mechanics. By ALFRED P. POORMAN. Second edition. McGraw-Hill Book Co., Inc.

English and Engineering. Edited by Frank Aydelotte. Second Edition. McGraw-Hill Co., Inc.